NEVADA DEPARTMENT OF TRANSPORTATION
FFY2015 RESEARCH PROBLEM STATEMENT

I. PROBLEM TITLE:
Maintenance Decision Support System (MDSS): Phase 3

II. PROBLEM DESCRIPTION
Growing demands for budgeting efficiencies, coupled with the a growing expectation from the public to keep roads clear of snow and ice can place strain on NDOT's winter road maintenance system. The development of a Maintenance Decision Support System (MDSS) would help mitigate these strains by reducing overload and increasing efficiency. The MDSS envisioned for NDOT will be capable of providing both real-time data to the main stations and improved two-way communications between drivers and dispatchers.

The Intelligent Transportation System (ITS) Mobile Observation (IMO) program was created by the U.S. Department of Transportation (USDOT) to investigate how weather, road condition, and related vehicle data can be collected, transmitted, processed, and used for decision making with ITS (Intelligent Transportation System), MMS (Materials Management System) and MDSS (Maintenance Decision Support System). For the past several years, NDOT has been collaborating with the University of Nevada, Reno (UNR) to develop multi-modal data telemetry capabilities using both Nevada's statewide Enhanced Digital Access Communications System (EDACS) and commercial cellular data technologies (e.g. 3G, 4G and LTE). To date, NDOT has deployed three-dozen winter maintenance vehicles equipped with weather and road condition sensors to help augment the statewide RWIS network.

During this period of collaboration both UNR and NDOT have made significant strides towards the eventual implementation of an MDSS system in Nevada. However, several key issues have been identified that must be resolved before NDOT can implement an MDSS.

III. OBJECTIVE
The main goal of the proposed project is to address the major barriers identified so that NDOT can begin implementing an MDSS system in Nevada. The six identified barriers each represent one objective and include: 1) identify the most appropriate performance measures for snow and ice management, 2) adding automated tracking of material usage, 3) adding compatibility with the planned P25 communication system, 4) studying the accuracy of the weather forecasts and MDSS treatment recommendations, 5) transitioning the data center and vehicle installations from UNR to NDOT, and 6) studying the intellectual property issues surrounding MDSS applications.

IV. CURRENT PRACTICE and RELATED RESEARCH
Although the ability to collect mobile observations has the potential to greatly enhance weather and road condition forecasts, the ability to send data and/or instructions to winter maintenance vehicle operators is a critical component of an MDSS system. No other DOTs use multi-modal vehicle telemetry with a combination of radio (EDACS) and cellular data. This is because most other states have extensive cellular coverage, making radio network-based telemetry unnecessary. Nevada is an exception to this, making systems such as EDACS or P25 essential—especially in rural Nevada.

Over the past several years, UNR and NDOT have collaborated to develop a system to meet Nevada's unique need for a system that permits two-way telemetry of data by automatically switching between EDACS and cellular data networks, depending on the availability of a cellular

signal. Because of the inherent bandwidth limitations of the EDACS radio system, the system developed "falls back" on the radio network with smaller (essential) subsets of the data stream.

Now that this essential methodology has been developed and tested at the prototype stage, NDOT is nearly ready to implement an MDSS in Nevada.

V. RESEARCH METHODOLOGY

The project tasks will include:

1. ***Investigate performance measures for snow and ice management:*** a quantifiable measure of performance would be beneficial for snow and ice management. This task will focus on evaluating (and if needed, work with NDOT to modify) existing performance indexes developed at other DOTs. The possibility of using a direct measurement of friction will also be studied.
2. ***Tracking sand and deicing material usage:*** tracking where and when salt/sand and/or deicing materials are used is a key part of upgrading the MMS system used so that overall winter maintenance material costs can be reduced. The prototype system that has been developed needs to be tested during a winter storm season. Once vetted, the system will provide NDOT with the ability to track the use of salt/sand and/or deicing materials.
3. ***Adding compatibility with the planned P25 communication system:*** the current IMO system uses EDACS, but requires one radio for voice and a second radio for data. This is not economically feasible for statewide implementation. Additionally, NDOT will be transitioning away from EDACS to Project 25 (P25) for statewide communications in the near future. The IMO hardware & software needs to be modified (prototype) to make it compatible with the P25 system.
4. ***Studying the accuracy of the weather forecasts and MDSS treatment recommendations:*** Nevada's many microclimates coupled with sparsely located RWIS stations have resulted in poor reliability weather forecasts and, hence, road condition predictions. The enhancement afforded by the mobile observations will be studied.
5. ***Develop a plan for transitioning the data center and fleet from UNR to NDOT:*** currently, the server that receives and processes data from the IMO vehicles resides at UNR and all of the IMO vehicle installations are maintained by UNR. A long-term plan needs to be developed to help transition both the server/software and fleet of IMO vehicle installations from UNR to NDOT. The plan will help the transition IMO from a research project based at UNR to a full implementation at NDOT.
6. ***Studying the intellectual property issues surrounding MDSS implementations:*** the group of patents issued to Concaten & IWAPI remains a concern for all DOTs using an MDSS. Nevada cannot proceed without developing a plan to address the intellectual property issues.

VI. IMPLEMENTATION POTENTIAL

As outlined above, the proposed work spans Stages II-IV, but is leveraged on the more mature IMO project, which is already in Stage IV at present. The tasks 1-4 (see above) of proposed project would be considered a Stage II/III project in that it will involve laboratory development and full scale testing in a single vehicle. Tasks 5-6 constitute Stage IV/V efforts.

Once completed, the project will enable NDOT to implement an MDSS in Nevada.

VII. URGENCY AND PAYOFF POTENTIAL

<u>*Urgency*</u>: Currently, UNR is under contract to provide NDOT access to the mobile observations only through December 31, 2014. Funding *in the next fiscal year* is essential to not only provide the

needed advances, but is needed to maintain project continuity, and best ensure that productive output can continue uninterrupted, and not lose ground by ceasing activity and potentially losing valuable personnel.

Payoff Potential: The proposed project seeks to address the final impediments to implementing an MDSS system in Nevada. Nevada can expect to see substantial savings if they chose to implement MDSS. Other DOTs have reported a reduction in their use of salt/sand by 20-40%. Using a conservative estimate of 20%, Nevada would still save about $530,000 annually based on the current salt/sand budget of about $2.6 million.

VIII. ESTIMATED BUDGET

The budget is estimated at $200k for 26 months (November 1, 2014 – December 31, 2016). The total includes professional salary, LOA salary, graduate student stipends, undergraduate wages and fringe benefits (including graduate student tuition), materials, supplies, publication, consultants, travel (both in-state and out-of-state) and overhead.

IX. DATE AND SUBMITTED BY

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X. NDOT CHAMPION

The MDSS project was originally championed by Bill Hoffman. For the past two years, the research team has held periodic meetings and teleconferences with Denise Inda (Chief Traffic Operations Engineer) and Mylinh Lidder (Assistant Chief of Maintenance and Asset Management) and have worked closely with the Equipment Division (for installation of equipment into NDOT vehicles).